LAMINATE

The invention relates to a laminate comprising a skin plate made from steel and a shaped layer, which shaped layer is joined to the skin plate and forms cavities and/or passages with the skin plate, which passages and/or cavities are optionally connected to one another.

Laminates of this type are known and are used for a wide range of applications, optionally also having been provided with a second skin plate so as to form a sandwich material.

An important object of a sandwich material or laminate is usually to provide a lightweight plate which is also strong. In particular sandwich materials are suitable for this purpose, since the core between the skin plates of a sandwich of this type can be produced from a lightweight material, while the (thin) skin plates together provide the strength.

One of the forms in which a laminate or sandwich of this type is known is what is known as honeycomb material, which is used in catalytic converters for vehicles. This material usually comprises one flat and one corrugated metal sheet, which are joined to one another, for example by soldering or brazing, with the laminate being rolled up in order to produce a catalytic converter with a large reactive surface area. Catalytic converters for vehicles have to be able to withstand high temperatures.

A sandwich material comprising honeycomb material in the true sense of the word is also known; in this case, honeycomb core material is accommodated between skin plates, with the walls of the honeycomb core material perpendicular to the skin plates. Honeycomb sandwiches of this type are known in a fully paper design or as paper core material between wooden panels; these sandwiches are relative inexpensive. Sandwiches of this type in fully metal form, for lightweight applications in aerospace and aeronautical applications, are very expensive, however.

It is an object of the invention to provide a laminate and a sandwich material which is lightweight, strong and inexpensive.

Another object of the invention is to provide a laminate and a sandwich material which are inexpensive to produce.

Yet another object of the invention is to provide a laminate and a sandwich material which can be used, for example, in buildings, the automotive industry, shipbuilding and the manufacture of equipment.

According to a first aspect of the invention, one or more these objects are achieved by a laminate comprising a skin plate made from steel and a shaped

layer, which skin plate has an outwardly facing side and a side which faces towards the shaped layer, and which shaped layer has a side facing towards the skin plate and an outwardly facing side, in which the shaped layer substantially consists of a shaped steel plate, which shaped layer is joined to the skin plate and forms passages and/or cavities together with the skin plate, which passages and/or cavities are optionally connected to one another, and in which a polymer material creates the bonding between the skin plate and the shaped layer.

Bonding the skin plate to the shaped layer with the aid of a polymer material creates a very simple joining technique for joining the metal skin plate and the shaped layer to one another. On account of the fact that polymer material has a softening range when it is heated, the joining is easy to carry out by heating the polymer material at least at the contact surfaces between the skin plate and the shaped layer. On account of the fact that the shaped layer leaves opens passages and/or cavities, it is possible to use these passages and/or cavities for design purposes, while the weight of the laminate also remains as low as possible, on account of the shaped layer not being solid.

It is preferable for that side of the skin plate which faces towards the shaped layer and/or that side of the shaped layer which faces towards the skin plate to be provided with a layer of polymer material. Providing the inner side of either the skin plate or the shaped steel plate with a layer of polymer material makes it easy for the two metal plates to be bonded to one another. It is preferable for both plates to be provided with a layer of polymer material on their inner side, since this produces excellent bonding and the passages and/or cavities between the two steel plates are completely surrounded by polymer material, so that there is no risk of rust forming on the steel plates. Obviously, it is possible, for example, to produce the skin plate from stainless steel; in this case, a layer of polymer material on the shaped steel plate is sufficient to prevent the formation of rust.

It is preferable for the outwardly facing side of the skin plate and the outwardly facing side of the shaped layer to be provided with a layer of polymer material. As a result, the outer sides of the laminate are protected against the formation of rust. It is also possible for the skin plate to be printed on or for the layer of polymer material to be coloured.

According to a preferred embodiment, a second skin plate is joined to the shaped layer in order to form a sandwich material. The second skin plate is also bonded to the shaped layer with the aid of the polymer material. As a result, the sandwich material is substantially just as easy to produce as the laminate as discussed above.

It is preferable for the shaped layer with the second skin plate likewise to

form passages and/or cavities, which passages and/or cavities are optionally connected to one another. It is therefore possible, for example, to create a sandwich material which has passages and/or cavities on both sides of the shaped layer.

In addition, it is possible for both sides of the steel shaped layer and/or the inwardly facing sides of the skin plates to be provided with a layer of polymer material. This gives rise, mutatis mutandis, to the same advantages as for the laminate.

It is preferable for the outwardly facing sides of the skin plates to be provided with a layer of polymer material. The same advantage applies here as for the laminate.

According to a preferred embodiment, the skin plate or plates are between 0.05 and 0.6 mm thick, preferably between 0.05 and 0.3 mm thick. Using steel skin plates of this thickness produces a laminate or sandwich of a very low weight, while the laminate or sandwich is nevertheless strong, on account of the use of the steel skin plates. The steel skin plate also has a good resistance to damage and the like.

It is preferable for the material of the shaped layer to be between 0.05 and 0.6 mm thick. Such a thickness of the shaped layer made from steel is enough to achieve a sufficient strength and rigidity.

According to a preferred embodiment, the layer of polymer material on the steel skin plate or plates and/or the steel shaped layer is between 0.015 mm and 0.7 mm thick, preferably between 0.03 mm and 0.2 mm thick. This type of thickness is sufficient to obtain good bonding. Steel plates with a polymer layer of this thickness are commercially available.

It is preferable for the polymer material to substantially comprise polypropylene (PP) or polyethylene (PET). These are known thermoplastics which have good bonding properties and are available as a layer with a suitable thickness on a steel sheet.

According to an advantageous embodiment, the passages in the laminate or the sandwich material are designed in such a way that the passages in the laminate can be used as one or more lines for transporting a fluid.

According to a preferred embodiment, passages and/or cavities in the laminate are filled with an energy-absorbing material. The laminate or sandwich material may then, for example, be used in the construction industry as an energy-absorbing material in, for example, walls, in order to attenuate the daily temperature change in the building.

According to another preferred embodiment, cavities in the laminate are

closed, and these cavities are under a pressure which is lower than atmospheric pressure. As a result, the laminate or sandwich material has a insulating property.

It is preferable for the laminate or sandwich material to be between 1 mm and 100 mm thick, preferably between 2 mm and 40 mm thick. These thicknesses are readily useable in all kinds of applications, such as in the construction industry, in shipbuilding and in the automotive industry, but the lower thicknesses can also be used, for example, in the packaging industry and the production of equipment.

A second aspect of the invention provides a method for producing laminate or sandwich material as described above, in which the skin plate or plates and the shaped layer are brought into contact with one another and the bonding between the skin plate or plates and the shaped layer is brought about by heating the polymer material. This method creates the bonding between skin plate or plates and shaped layer in a simple and inexpensive way.

The heating is preferably realized with the aid of induction heating or with the aid of radiant heat. These ways of supplying heat can be used in a simple and inexpensive way on an industrial scale. Induction heating is possible on account of the fact that the skin plate or plates are made from steel.

According to a preferred embodiment, the laminate (or sandwich material) is produced substantially continuously. This makes it possible, for example, to supply the skin plates from a coil; the laminate produced may if appropriate be coiled or processed to form plates; sandwich material produced will have to be processed to form plates.

It is preferable for the steel shaped layer to be shaped substantially continuously before being brought into contact with and bonded to the skin plate or plates. This allows the laminate or sandwich material to be produced continuously by supplying two or three steel strips from a coil and shaping one of them, so that the strips can be bonded to one another by heating. One or more of these strips will usually be provided with a layer of polymer material on one or both sides, although it is also possible for the layer of polymer material to be supplied as separate strip.